Open Questions in Defense Economics and Economic Warfare

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A distinction is made concerning five distinct war scenarios, and a discussion is given of the different economic requirements for each of these scenarios. These requirements pose a considerable number of new economic problems that were not present in defense economics prior to World War II.

Economics has been called the "dismal science." Its application to war will not lighten the epithet. Yet the failure to apply economic reasoning to war makes war an even more damaging occupation than it might be otherwise. In the past 20 years, relatively little economic analysis of defense problems has been conducted. The enormous cost and terrible destructive power of modern weapons, the rapid integration of international product and financial markets, and the recurring problems of military production and coordination make it desirable that economic investigation of these and other defense-related questions resume at the level of intensity with which it was conducted during the late 1950s and early 1960s. This paper identifies some of the topics that most urgently need reexamination and outlines the role economic analysis can play in understanding them. Our purpose is not to present an exhaustive study of these problems, but to indicate the scope of what must be done.

United States involvement in the Vietnam War destroyed an American political consensus concerning the proper scope and size of the military establishment. The resulting self-doubt and recrimination have severely eroded public support for and academic interest in strategic

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studies that have military applications. Thus, a missing generation of defense analysis is yet another legacy of this most unpopular war. Since the work of the 1950s and 1960s (e.g., Hitch and McKean, 1963; Hitch, 1965; Enke, 1967; Schlesinger, 1960; and many others), important gaps have developed in our knowledge and analysis.

In the past 25 years, both the world economic system and our military capabilities have changed dramatically. The rapid growth of international trade (U.S. gross trade as a percentage of GNP grew from 6.8% in 1960 to 17.7% in 1980) creates powerful linkages between the economic affairs of sovereign nations. New military hardware such as tactical nuclear weapons and space-based strategic defenses introduce entirely new elements into strategic planning for the last decade of the twentieth century. It is our belief that defense economic analysis has not kept pace with these changes.

This is not to say that there have been no contributions to the field for two decades. For example, the political debate on an all-volunteer army motivated considerable economic analysis (e.g., Altman and Fechter, 1967; Ash et al., 1983). More recently, Kanter (1984) offers a brief overview of defense economics from 1776 to 1983. He concludes that only in the twentieth century have massive mobilizations dominated the industrial economies in wartime. Kanter also considers whether economic growth can be sustained with a heavy military expenditure. Although he notes the importance of strategic analysis, Kanter does not analyze the relationship between the problems of defense economics and economic warfare. Scharfen and Ball (1983) also briefly consider economic warfare, but their conclusions reinforce the observations of Kanter (1984) and Shubik (1979) that the concern for both defense economics and economic warfare in the 1970s and 1980s has been slight. However, other recent publications such as Kennedy (1983) and Olvey, Golden, and Kelly (1984) may signal a renewed interest in defense economic analysis. In this article, our purpose is to reinforce this nascent trend.

Of course, overreliance on academic research can be as crippling as ignorance of it. The grand strategic vision of a military commander or civilian defense planner cannot be captured in formal models. However, virtually every aspect of military and strategic planning is amenable to some form of economic analysis. The complex strategic problems associated with testing, deploying, limiting, and verifying nuclear and conventional forces cry out for game theoretic and formal strategic analysis. Attempts to discover the influence of international trade on our domestic economy demand detailed structural modeling and empirical investigation because the magnitude and even the direction of the effects cannot be surmised. It is these and similar questions to which academic attention must be directed.

The economic problem of defense requires us to evaluate the absolute level of defense expenditure and the trade-off of expenditures at all levels. Thus, rescue missions in Lebanon, insurgency in Angola, liberation movements in Afghanistan or Cambodia, small wars in Africa, coups in the Caribbean, adventures in the Falklands, intervention in Iran, war in Central Europe, and all-out thermonuclear war must all be considered part of an integrated defense posture.

Both political and economic costs are relevant to evaluating these trade-offs. The wise policymaker is, and probably should be, skeptical of highly formal mathematical models applied to the type of "squishy" problems with which he or she deals. But the formal methods of economics and game theory have a crucial role to play if used carefully. Even oversimplified models reveal critical assumptions and may suggest the consequences of relaxing these assumptions. The strategic value of a base in the Philippines is a policy judgment, but its costs and benefits and their sensitivity to alternative assumptions can only be discovered through research.

DISTINGUISHING DEFENSE ECONOMICS AND ECONOMIC WARFARE

Before considering specific questions in the economics of defense and economic warfare, we offer our own definitions of these terms. *Defense economics* consists of applying economic analysis to national defense issues. As economics is a science of choice, so defense economics is a systematic study of choices from among competing alternatives. Examples of these choices include the level of defense spending, the mix of public and private weapons production, and the attention paid to the macroeconomic effects of defense activities. In the field of defense economics, the analytical problems range from almost pure economics (e.g., the cost of feeding troops in peacetime) to grand strategy that has economic implications (e.g., a decision to attack economic targets).

Economic warfare is the use of economic weapons for strategic purposes. It is closely related to the literature on oligopoly, monopolistic competition, bargaining, and other aspects of competition (Zeuthen, 1930). The analyst must account for the reactions of the enemy, and the strategic analysis involves a blend of military, political, and economic considerations not usually considered in most defense economics studies. Defense economic analysis, which focuses narrowly on costs and production, is a safer and more institutionally acceptable topic for study than is economic warfare. An explicit link to policy brings the latter field far closer to strategic studies than, say, a cost estimate for the design of a new piece of ordnance.

While defense economics encompasses any application of economic analysis to defense, the study of economic warfare focuses more narrowly on the use of economic weapons. These weapons certainly include sanctions, embargos, and cartels. Industrial mobilization, arms races, and the stockpiling of strategic materials occupy a gray area often not analyzed under the rubric of economic warfare (e.g., Hitch and McKean, 1963). However, each of these latter subjects involves important economic decisions that make the analysis highly sensitive to assumptions concerning strategic posture. Finally, attacks on economic targets may also be analyzed as economic warfare. Such attacks undoubtedly influence the ability of a country to wage war. Although they achieve this influence through military means (e.g., sabotage, mining, blockade, bombing), the attacks aim to reduce the *economic* potential of the enemy.

TYPES OF ANALYSIS AND METHODOLOGY

The fundamental difference between cost-based analysis of generic defense economics topics and the more complex interdisciplinary strategic analysis of economic warfare suggests that a systematic understanding of the various types of defense economic analysis would be valuable.

One useful methodological distinction is the degree to which the analyst considers the enemy response. There are three broad classes of analysis. Studies in the first category of analysis assume no enemy response. This type of analysis is primarily relevant to technical questions concerning such issues as the choice among available production methods where our choices are unlikely to affect enemy strategy. For example, this category characterizes engineering studies of the least-cost method of producing military hardware or transporting troops in peacetime. Work in the second category, while still employing the method of constrained maximization, introduces explicitly the enemy's reaction to our choices. Such studies consider only the local response, where "local" has both a spatial and temporal meaning. They are analogous to partial equilibrium analysis in economic theory. Work in the third category considers overall strategic action and cannot be treated as a strictly economic problem. In this mode of analysis, quantification becomes increasingly difficult; sociopolitical considerations may predominate. At times, it may only be possible to describe the important strategic interactions and to rank them according to their relative importance.

The perspective of the analyst is also important. Our own analysis emphasizes the overall economic viewpoint of the United States. But because the Soviet Union, the United States, and third parties perceive economic problems very differently, symmetry assumptions (e.g., assuming Soviet problems are like ours) may be dangerously misleading. These assumptions are particularly damaging when our own strategy depends on that of our adversary. Such a restriction to symmetric strategies is analogous to naive market models in which the variety of different strategic weapons are neglected. For example, public opinion and political pressure play such dramatically different roles in the United States and the Soviet Union that these influences on defense policy produce profoundly different policy reaction times and levels of political control. Recognizing the asymmetry of these interactions significantly alters the strategic equilibrium, both in markets and in international affairs, from the predictions of a model employing a symmetry assumption.

Equally dangerous is the penchant to view potential conflict as only bipolar. For example, China and France are not merely potential allies of the Soviet Union and the United States, respectively, but independent entities whose goals often diverge from those of both superpowers. These and other "third parties" have become increasingly important in international affairs; for example, they may start wars, unbalance international trade, or promote terrorism.

DISTINGUISHING WAR SCENARIOS

In considering the diverse topics subsumed under defense economics, we find it helpful to distinguish among five broad scenarios of international conflict. These are cold war, proxy or client war, limited war, full conventional war, and nuclear war. We recognize that these categories sometimes overlap. However, the use of these scenarios allows us to consider the different economic problems that arise at each level of conflict.

The term *cold war* refers to superpower conflict conducted without overt violence and, less conventionally, includes all nonviolent conflict between superpowers and third parties and among third parties. "Peace," "peaceful coexistence," "containment," "peaceful competition," and "cold war" each describe some aspect of international relations in the absence of a shooting war. However, true peace, such as prevails among European Community nations (or OECD countries), differs markedly from the state of global tension often described euphemistically as peaceful competition. Cold war involves competition in deploying and maintaining vast arsenals of weapons as well as enlisting, training, and supplying large standing armies. For example, the Soviet and U.S. navies operate in every ocean. Both countries have thousands of troops permanently stationed far from their national territory, and superpower nuclear missiles are based in NATO and Warsaw Pact countries.

At the next level of conflict, the distinguishing feature of a *proxy* or *client war* is that none of the superpower's troops are involved in combat. This category covers a wide range of superpower involvement from small scale covert supply operations to massive supply and logistic support. Of course, a proxy or client war can occur during a period of cold war. In fact, proxy and client wars appear to have become more frequent since World War II, perhaps reflecting the increased risk of direct superpower involvement in the nuclear age. Examples of such conflicts include the United States' support for anti-Sandinista forces in Nicaragua, and Soviet support for Cuban assistance to insurgents in El Salvador and to the government of Angola.

At a still higher level of conflict, *limited war* involves the combat troops of at least one major power. A working definition of a "major power" for these purposes is a country with a substantial nuclear capability. For example, Britain fought a limited war against Argentina. But it is unlikely that the Soviet Union, the United States, Japan, or most European powers would risk a limited war where the forces of the Soviet Union and a major democratic power might risk direct confrontation and potential conflict escalation. This fear of direct conflict, we believe, has led to the growing reliance on proxies. Of course, a limited war for one side may be a proxy war for the other. Thus, Vietnam was a limited war for the United States, but a proxy war for the Soviet Union. The war in Afghanistan is the reverse. The Iran-Iraq war and the Arab-Israeli conflict show that it is also possible to have both sides as clients. Understanding the political economy of modern proxy war is increasingly important because, at least in Western democracies, the political necessity to generate popular support for proxy wars may strongly dominate military and strategic considerations.

At the highest level of nonnuclear conflict, *full conventional war* involves combat troops of two major powers. Conventional war is expensive, and, by virtually any measure (such as the cost of troops and equipment, or the per capita cost of inflicting casualties), it appears to be growing more expensive. It is perhaps the staggering cost of such a war that has caused the major powers, during the last half of the twentieth century, to avoid direct confrontation on the battlefield.

Nuclear war is the use of strategic nuclear weapons. The great attraction of nuclear weapons was economy. But this has proved to be a false economy. Nuclear arsenals have grown rapidly, and the delivery systems for nuclear weapons have become increasingly expensive to build and maintain. Furthermore, crises and war are on a continuum and not on a simple "yes-no" basis. Each set of still deadlier weapons expands the range of potential responses rather than dividing it into peace or holocaust. This principle of graduated response suggests that a holocaust reply to a conventional attack may be extremely unlikely. Thus, if tactical nuclear weapons are cheaper than their nonnuclear substitutes, they might be used. But battlefield nuclear weapons appear designed to provide an easy way to blunder into World War III by confusing the question of whether a conventional war has gone nuclear. The military strategist thus faces an ironic dilemma. Nuclear weapons deliver greater firepower per dollar than any conventional weapon, but their use invites cataclysmic consequences. In short, why blow up the world for Frankfurt? This paradox suggests that economic strategic analysis of nonnuclear war may be far more important than the dearth of recent literature would indicate. What are the economics of limited war and conventional war in the 1980s and 1990s? What are the cheap weapons (if any) that would stop a conventional attack through the Fulda Gap? These and other questions relating to conventional war urgently need to be answered.

The massive nuclear arsenals built in the 1970s and 1980s have created a new class of warfare. Since Clausewitz and Jomini, strategists have discovered tactics, strategy, and grand strategy. Tactics involve engagements that are limited in both space and time. Strategy is on a larger scale in both dimensions. Finally, grand strategy deals with the overall politico-military aspects of the war as a whole. But nuclear weapons combined with rockets have created a new possibility. Strategic annihilation may occur as quickly or even more quickly than a tactial engagement. Conventional studies of strategic mobilization, logistics, and blockade involve lengthy time horizons. But Day 10 of a nuclear war could be its end. Or is the next stage of conflict a conventional war fought by the surviving powers? The early 1960s saw a boom of provocative literature on nuclear problems and related game theory. Examples of such high quality work include Kahn (1961, 1962), Brodie (1959), Ellsberg (1961), and Schelling (1960). The scale of modern nuclear arsenals suggests that this effort should be renewed with vigor.

PRELIMINARY OBSERVATIONS ON SOME OF THE OPEN QUESTIONS

Because the purpose of this article is to stimulate research and discussion of defense economic problems, this section presents a framework for analysis and offers preliminary observations on some of these issues. Table 1 presents a matrix of topics in defense economics and economic warfare. It portrays the variety of economic problems that appear and vary from scenario to scenario. We designed the matrix as an organizing device for our own work. The column titles of Table 1 are the various war scenarios that must be considered separately. The row titles indicate general subjects that are the basic content of the economic analysis of war. Each cell entry of the matrix contains one or more topics.

PRODUCTION PROBLEMS

The foundation of large-scale warfare in the twentieth century has been the mass industrial production of weapons. The problems of defense production are among the most thoroughly studied questions in defense economics. The application of industrial organization economics to defense production and procurement has been traditionally one of the most useful applications of defense economics. For example, the economics of specialized production with indivisibilities and substan-

TABLE 1
Economic Analysis of War

Topic	Cold War	*Proxy or Client War*	*Limited War*
Logistics and Convoys	Contingency plans Intelligence and covert operations Terrorism Boot on the ground as deterrent Nonclient small wars	Surreptitious vs. overt supply (e.g., Afghanistan via Pakistan) Covert operations against enemy supply lines (Afghans attack with heat-seeking missiles; mining Nicaraguan harbors)	Harassment Refueling, coaling stations
Mobilization	Contingency plans Exercises Sizing surge capacity Public vs. private tradeoff Mobilization war triggered by crisis	No mobilizations Reserves and readiness as a deterrent to hostile entry	Partial mobilization Increase reserves Improve readiness Public control of production?
Sanctions, Sabotage, and Embargos	Harassment Financial, industrial, and military sabotage Illicit trade	Harassment Economic threats to trading partners	Siege warfare

Strategic Materials	Stockpiling Autarky	Denial of materials to enemy and enemy's clients	Denial of materials Attacks on economic potential Short-term elasticities
Blockade	Is this still a strategic option (e.g., Cuba)?	Mining operations	Mining Fleet blockade
Cartels	Cartels have coercive power in disputes	Some coercive power	Military power predominates through the threat of invasion
Arms Races	Choice of force structure (e.g., nuclear triad) Offensive vs. defensive weapons (e.g., SDI) "Peace" movements Alliance politics	Choose level of weapons technology supplied to proxy or client	Cost and value of slow, long client war (e.g., Vietnam, Afghanistan)
Arms Industry	Production, R&D for arms races Increasing returns to scale and international arms trade	Arms sales and supplies in "little wars" Issue of control	Arms sales and supplies Surge capacity Lead time in a crisis
Finance	Use of debt to gain political leverage Sabotage Financial support of threatened regimes	Financial support of proxy Hindrance, denial for enemy	Blocking accounts Freezing assets Runs and panics Financial consequences of mobilization

(continued)

TABLE 1 Continued

Topic	*Conventional War*	Nuclear War	*General Comments*
Logistics and Convoys	Points of vulnerability Choke points War length Rate of resupply (e.g., Yom Kippur War)	Limited vs. Armageddon Communications and transport Supply from unaffected areas? Third parties War length	Logistics and transportation economics Role of marine vs. air supply routes Institutions and authority (especially interservice) Basing problems
Mobilization	Total mobilization Full manpower Maximum readiness Public control of production? Allied supply to U.S.	Mobilize for a conventional war after nuclear recovery What will be left? How does the war end? Who wins?	Role of marine vs. air supply routes Institutions and authority What kind of economic control? Intelligence "Industrial policy"
Sanctions, Sabotage, and Embargos	Siege warfare (Phnom Penh, Beirut, Pusan, and Leningrad)	Interdiction of postwar aid	Damage exchange Effectiveness Preemptive buying Export controls
Strategic Materials	Relative value of attacks on economic potential Short-term elasticities	Are supplies inaccessible or destroyed?	Lack of materials may limit surge capacity
Blockade	Siege warfare Control of SLOC and military-economic consequences Mining Fleet blockade	Primitive blockade could cut off food supplies from unaffected areas	Sabotage Permeability Could impede convoys and mobilization

Cartels	Cartel members subject to invasion	Unaffected nations become relatively more powerful	Political aspects Economic aspects Role of corporations in international disputes
Arms Races	Economics of countermeasures	Prewar selection of nuclear forces	Damage exchange Indices of damage Political will Role of domestic and international politics
Arms Industry	Role in mobilization and resupply cycle	Speed of recovery Amount of resiliency	Political economy of the arms industry Procurement in markets with one buyer and a few sellers Bureaucratic incentives for weapons evaluation
Finance	Financing mobilization Control of inflation Sabotage and esoteric forms of financial warfare	EMP effect on the banking system Can the government tax or borrow? Culpepper switch	Strategic default Bureaucratic difficulties

tial set-up costs for manufacturing items such as tanks or planes suggests the desirability of coproduction. Thus, we observe the United States' F-16 agreement with Belgium, Holland, Denmark, and Norway, and the British Tornado program involving West Germany and Italy. The French arms export support program illustrates the role that export sales can play in reducing unit costs.

In the United States, private firms produce virtually all military hardware. The defense industry itself is, at best, oligopolistic. It is at the forefront of innovation and intimately involved in international trade, and the demand for its products depends almost completely on the political process. Such an industry poses great challenges to economic analysis. Because few *a priori* statements can be made about costs, and because cost functions are notoriously difficult to estimate, detailed *ad hoc* models of the specific production processes are required.

The existing literature on defense production is rich, although the many changes in weapons technology and economic science during the past two decades suggest the value of reexamining the field. Adam Smith (1776) noted the special duty of the sovereign to defend the state and discussed the attendant costs of providing this defense. Alexander Hamilton (1791) favored protection to promote an industry capable of supplying military needs, and weighed whether armaments should be supplied by a governmental industry or by private firms. In fact, the great light arms industry of New England at the time of the Civil War was a production of individual entrepreneurship and government interest in standardization with the Harper's Ferry establishment playing an important role (Hounshell, 1984). Peck and Scherer (1962) apply industrial organization economics to the problems of weapon development and procurement. They demonstrate the importance of and difficulties with the economics of the defense industry. The more recent, but less analytical, work of Gansler (1980) provides examples of the many difficulties in comprehending the economics of the defense industry.

BUDGETING AND COSTS

War always has been an expensive business. The phrase "winning the war decisively" has a clear and morally imperative meaning to the military. But the clarity of mind and unity of purpose needed to destroy an enemy often produce a mindset, if not opposed to, then at least not consonant with, the views of auditors, economists, and politicians in a democratic society.

To maintain peace, a sovereign nation must be adequately supplied with the means to wage war. Unfortunately, in spite of, or perhaps because of, advances in technology, the means to wage war have remained an expensive part of the modern economy. We suggest that in a world with the threat of nuclear war, where at least two countries operate, at great cost, vast command-and-control systems involving tens of thousands of individuals and constant surveillance (Bracken, 1983; Blair, 1985), deep consideration needs to be given to the delicate balance of bankruptcy that accompanies the delicate balance of terror. Phrased differently, not only are vast command-and-control systems complex and susceptible to human and mechanical error but they are becoming so expensive that they can bleed an economy white. In spite of the growth in lethality of weapons, it appears that we now have "more bucks for the bang" rather than vice versa.

MEASUREMENT PROBLEMS

The accurate measurement of defense expenditures is notoriously difficult for at least three reasons: (1) budget and production secrecy, (2) conceptual definitional problems, and (3) empirical measurement errors (Treml and Kostinsky, 1982; Rosefielde, 1982; Wolf et al., 1983). The secrecy aspects of Soviet and other military expenditures need little elaboration.

Definitional problems pose difficulties especially because the political discourse in a democratic society depends significantly on how the public and its political representatives perceive trends and magnitudes. A busy legislator has little time or patience to consider the details of whether a scientific research project with military application should be imputed to defense expenditures or pure science. Yet, when discussing "missile gaps," science gaps, civilian-defense differences, and other economic efforts closely related to overall military strength, the reclassification of costs and activities can produce trends in any direction. Technical difficulties, such as selecting an exchange rate for the ruble or imputing a price where no open market exists, also are enough to reverse a trend.

COORDINATION PROBLEMS

A Nimitz-class carrier may take 10 years to complete, especially when one includes the planning and paperwork needed prior to actual construction (Livne and Shubik, 1982). Some construction times are in the range of 5 to 10 years, and weapons systems design-and-production cycles may stretch out 10 to 20 years (with frequent change orders imposed on the production process). The political cycles of two, four, and six years (House, Presidency, and Senate) in the United States also impose substantial uncertainty on the weapons-procurement process and produce difficult coordination problems.

The turnover rate in senior military posts further influences the severity of coordination problems. Table 2 shows the time in post for some senior Soviet naval personnel. From August 16, 1949, until 1984, the United States had 10 chairmen of the Joint Chiefs of Staff (*Defense*, Sept. 1984, p. 11), giving an average time in office of three to four years. It is an open question as to what are the benefits and drawbacks in the trade-off between fast and slow turnover in high command positions. There appear to be considerable differences in length of tenure in the Soviet and U.S. systems, although the British and French systems do not appear to be as short-term as that of the United States.

SPECIAL PROBLEMS OF NUCLEAR WAR

The domain of economic analysis relevant to war ranges from the most mundane technical assessment of the costs of moving a ton of food from point A to point B, to the cost-benefit analysis of alternative nuclear war scenarios. For obvious reasons, we are all most concerned about the consequences of a nuclear war. The principle of flexible response is an essential component in a strategy to avoid nuclear war. Situations that have been static for decades may for a brief time become fluid and ill-defined. For example, there are several "traditional boundaries" between France and Germany that are stable for some period until a moment of opportunity arises. The Napoleonic Wars, World War I, and World War II each involved attempts to exploit such an opportunity. Currently, the situations in Hungary and Czechoslovakia may be regarded as stable. But when matters change, the critical feature that will determine what results from the period of fluidity will be the preparations by all parties to handle conflict at every level without having to dichotomize between peace and nuclear holocaust.

TABLE 2
Time in Office: Soviet Navy

Position	Date of Assignment	Tenure
Commander-in-Chief Gorshkov	1956	26
First Deputy	1974	8
Chief, Main Naval Staff	1981	2
First Deputy	1976	6
Chief, Political Administration	1981	2
Chief, Shipbuilding & Armaments	1966	16
Chief, Technical Readiness	1970	12
Chief, Naval Aviation	1982	1

SOURCE: Soviet Armed Forces Review, 1982-1983.

Realistic estimates of the consequences of various types of nuclear war will spur reluctant policymakers to appropriate money and plan for the conventional forces that are the backbone of a flexible response strategy. The implications of Herman Kahn's (1962) warning do not appear to have been fully appreciated, even in current thought. He warned of the effects of a failure to estimate and analyze the potential effects of nuclear war. In *Thinking the Unthinkable*, his message was that to invoke a scenario of utter horror is an unsound psychological device to rationalize this failure to face the question. The approach of sticking a "minus infinity" into nuclear war payoffs helps to justify the value of a massive retaliation threat. But, by the same line of reasoning, no sane individual or group would carry out a massive retaliation unless it were an act of revenge or desperation.

For a threat to be plausible in international affairs, the magnitude of the transgression must affect the severity of the threatened response. In particular, economic reasoning makes policies such as massive retaliation suspect from the start. A blanket policy of massive retaliation that fails to link the punishment to the level of aggression may be a logically feasible threat, but the likelihood that it will be carried out varies with the magnitude of the aggression. Putting aside the technological barriers for a moment, the Strategic Defense Initiative raises the interesting question: How should we expect a defensive arms race to differ from an offensive one? The analysis by O'Neill (1987) suggests that the answer may depend upon the values of specific parameters. Thus, this work offers at least a partial answer to one of our open questions.

Conventional strategic analysis may in fact be somewhat constraining for the study of some defense problems. A central axiom of such analysis is that players are fully rational expected-utility maximizers. But players also may adopt rules of thumb instead of fully optimal strategies when full information maximization is beyond their rational abilities. The idea of bounded rationality originally put forward by Herbert Simon has been applied successfully to problems in contractual relations, organizational structure, and political systems. We believe that innate limits on human intelligence and information-processing ability act to dramatically limit the scope of their strategic optimization. A formal statement of the reason that players adopt rules of thumb might simply postulate that the costs of optimizing in the face of bounded rationality are, in some situations, exceedingly large.

This postulate embodies the possibility that agents' behavior will be affected by custom and tradition—a point hardly new to most readers of the *Journal of Conflict Resolution.* But it is a fact of life often resolutely ignored by those who stress pure individualistic economic analysis.

It is the imitative and evolutionary character of the resulting behavior that distinguishes rules of thumb from individual maximization. Far from adopting a rule of thumb from scratch, players use the experience of others and their own prior experience with various strategies to narrow the range of choice. An obvious effect of this imitative process is that a clearly superior strategy (i.e., strongly dominant strategy) may remain unplayed if it is far outside of the range of societal and personal experience. For example, it is possible that unilateral nuclear disarmament on the part of one of the superpowers could push the international community into a dramatically Pareto-superior equilibrium. Whatever the ultimate outcome might be, the risks associated with trying such a strategy violate the conservative and incrementalist rules of thumb that are dominant in international affairs. It is beyond our social and political capacity to anticipate the global repercussions from such a dramatic change in strategy.

CONCLUSION

In the overview of defense economics presented here, the stress has been on economic analysis. But war is not economics alone (or vice versa). For example, the economics of logistics support, convoys, and blockades in the 1990s cannot be fruitfully discussed without understanding the performance of new marine and air technology, which is essentially an engineering problem. Psychology, operations research, and technology appear far enough apart that a research program involving one rarely involves a high level of expertise in the other topics. But our ability to plan for the redundancy needed in man-machine systems operating under stress depends directly upon our knowledge of how human decision making changes under stress. How relevant is the operations research and game theoretic view of optimizing behavior under risk? How valuable is it as a norm that should be followed?

The change in the nature of the technology of war both in the nature of weapons and the structure of communication has been so radical in the past 30 years that the need to combine technological, economic, and strategic military studies has increased substantially. The Soviet Union appears to face similar problems to those of the West. It appears that more stress is placed in the Soviet Union on the role of operations research, game theory, and other mathematical methods in the study of defense. Examples include publications such as *Concept, Algorithm, Decision* (Druzhinin and Kontorov, 1972), with a foreword by General Shtemenko, and *Game Theory for the Naval Officer* (Suzdal, 1976), with a review by Vice Admiral V. Babiy. However, a close perusal of these books and other Soviet operations-research literature shows few Soviet references. We have the impression that in spite of considerably more lip service being paid to decision theory and to military operations research education, joint studies involving an intermix of economic analysis, operations research, technology, and strategic military analysis do not exist or are highly classified.

Much of microeconomic analysis and operations research is ahistoric. Yet the study of war and peace calls for both calculation and a sense of history, geography, and society. In the best of circumstances, cross-disciplinary work is difficult to do well. When scholarship has to mix with ongoing decision processes, the difficulties in maintaining objectivity and relevance are compounded.

For the most part, the study of defense problems is not "art for art's sake." The study of defense and with it the better understanding of the conditions needed for peace is, in our estimation, a social duty as well as an exercise in scholarship that should involve the scientific community as both citizens and scholars. The increases in complexity of technology, speed of communication, lethality of weapons, and population size have made the problems of defense more critical to study and have changed radically many of the basic problems in defense economics in the past few decades. This survey has tried to sketch some of these changes and to indicate their importance.

The next 20 years may see changes even more radical than the past 20. The revolution in the speed of computers and communication networks has only begun. The same holds true for the nature of new weaponry. Yet the political economy of the control of defense needs to society has hardly changed at all. These comments are not meant as a counsel of despair. Ongoing processes "solve" all problems in the sense that the system moves in some way or another from its state at t to some state at $t + 1$. The challenge we offer is to consider how much scholarship can influence the future state of a system that affects human prospects so profoundly.

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